

MISCELLANEOUS PROCESS METHODOLOGY 7.5 Agricultural Harvest Operations

(Updated April 2016, Revised March 2017)

EMISSION INVENTORY SOURCE CATEGORY

Miscellaneous Processes / Farming Operations

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION

620-615-5400-0000 (83980) Agricultural Harvest Operations

Method Summary. The agricultural harvest operations category estimates the airborne particulate matter (PM) emissions from soil and plant material produced during the harvesting of agricultural commodities. Harvesting operations include crop harvesting and the first post-harvest processing stage (packing houses, nut hullers and processors, cotton gins, dehydrators, feed and grain mills). Emissions vary seasonally and regionally according to the crop mix and the intensity of harvest activities taking place, with the highest emissions occurring during the peak harvest months of summer and fall.

ARB estimates harvesting emissions for each crop by multiplying harvested acreage (activity) by a crop specific emission factor. Associated emissions from all crops are summed by county, then allocated to the 69 air basin/county/air district regions (COABDIS) regions. Emission estimates in this update were developed for the 2016 ozone SIP inventory, Version 1.04. More information on method development is provided at the embedded links below, in the references, and in the Supporting Documentation section of the methodology's webpage at <http://www.arb.ca.gov/ei/areasrc/arbmiscprocfarmops.htm>.

Activity Data Source. For this update, 2012 harvested acreage from the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS), compiled from County Agricultural Commissioner reports, was used for all regions (<http://www.arb.ca.gov/ei/areasrc/fullpdf/2012acreage.pdf>). Acreage for pasture lands, mushrooms, greenhouse, nursery and flower crops, forest firewood, and acreage aggregated statewide as "Sum of Others" was excluded. Harvested acreage for counties split among two or more air basins was apportioned based on land surface areas compiled by ARB (ARB, 2009), except for Kern County, which was assigned 98% to the San Joaquin Valley Air Basin (SJV AB) and 2% to the Mojave Desert Air Basin.

For non-SJV AB regions, each crop was assigned to one of 20 crop profiles, which were developed in consultation with growers and other agricultural experts to reflect current California growing practices (CARB, April 2003). The profiles are based on

representative crop calendars ([Crop Calendars](#)), which provide information about the type of harvest operations, their frequency, and the times of year they occur. In March 2017, the SJV Air District developed 26 additional crop calendars to further refine the timing of crop-specific harvesting operations. For SJV regions, crops were assigned to one of the 46 crop profiles developed from the refined calendars (http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/EmissionsMethods.htm).

Emission Factor Source: Emission factors (lbs PM10/acre/year) are based on California testing conducted in almonds, cotton and wheat (Table A). The almond harvesting emission factor is based on studies conducted between 2002 and 2010 [Faulkner, 2010; Jones, 2008; Spencer, 2012]. The emission factors for almond sweeping and pickup are from the Faulkner study. The almond shaking emission factor is based on the average of shaking results from the Jones study, which used two testing methodologies. The cotton and wheat harvesting emission factors are from a 1994 - 1998 study performed by the University of California, Davis, under contract to the USDA [Flocchini, 2001]. Based on assumptions about the emission generation potential of crop specific harvesting practices, ARB developed nine scaled emission factors from the almond, cotton and wheat emission factors, and assigned them to over 200 commodities.

Table A. Emission Factors for California Harvesting Operations

Agricultural Harvest Operation	Emission Factor (lbs PM10/acre/year)
Almond	
Almond Shaking	3.47
Almond Sweeping	4.15
Almond Pickup	23.6
Almond Total	31.2
Cotton	
Cotton Picking	1.685
Cotton Stalk Cutting	1.685
Cotton Total	3.37
Wheat	
Combining	5.8

Emissions. Crop specific PM10 emissions (lbs PM10/year) were estimated by multiplying harvested acres by the associated emission factor. Emissions from all crops were then summed for each COABDIS region. Total PM and PM2.5 are derived from calculated PM10 emissions using ARB’s speciation profile #417 for agricultural tilling dust. Particle size fractions are based on an average of dust measurements from 8

fields in the San Joaquin Valley and on 2006 updates to ARB PM2.5 speciation profiles [Houck, 1989; Cowherd, 2005; Gaffney, 2006].

$$\text{Total PM} = \text{PM10}/0.4543$$

$$\text{PM2.5} = (\text{PM10}/0.4543) \times 0.0681$$

Table B provides crop profile assignments, emission factor assumptions and PM10 harvesting emission factors, by CDFA commodity, for all crops harvested in California in 2012. Table 1 presents PM10, PM2.5 and total PM emissions from 2012 agricultural harvest operations, along with harvested crop acreage, by COABDIS region.

Table B. Crop Emission Factor Assumption and PM10 Harvest Emission Factor

CDFA Commodity Code	CDFA Crop Description	ARB Crop Profile	Crop EF Assumption	Harvest EF (lbs PM10/acre/year)
101999	WHEAT ALL	Wheat	Wheat/1	5.80
104999	RYE FOR GRAIN	Wheat	Wheat/1	5.80
106199	RICE, FOR MILLING	Rice	Cotton/2	1.68
106269	FIELD CROP BY PRODUCTS	Cotton	Cotton/20	0.17
108999	FOOD GRAINS, MISC	Corn	Cotton/2	1.68
111559	CORN, WHITE	Corn	Cotton/40	0.08
111991	CORN FOR GRAIN	Corn	Cotton/2	1.68
111992	CORN FOR SILAGE	Corn	Cotton/20	0.17
112999	OATS FOR GRAIN	Wheat	Wheat/1	5.80
113994	BARLEY, MALTING	Wheat	Wheat/1	5.80
113995	BARLEY, FEED	Wheat	Wheat/1	5.80
113999	BARLEY, UNSPECIFIED	Wheat	Wheat/1	5.80
114991	SORGHUM, GRAIN	Wheat	Wheat/1	5.80
114992	SORGHUM SILAGE	Wheat	Wheat/1	5.80
115991	TRITICALE	Wheat	Wheat/1	5.80
121219	COTTON LINT, UPLAND	Cotton	Cotton/1	3.37
121229	COTTON LINT, PIMA	Cotton	Cotton/1	3.37
121299	COTTON LINT, UNSPEC	Cotton	Cotton/1	3.37
132999	SUGAR BEETS	Sugar Beets	Cotton/2	1.68
151999	COTTONSEED	Cotton	Cotton/1	3.37
153999	PEANUTS, ALL	Safflower	Cotton/2	1.68
158269	SAFFLOWER	Safflower	Wheat/1	5.80
158316	SUNFLOWER SEED, PLANTING	Corn	Wheat/1	5.80
158319	SUNFLOWER SEED	Corn	Wheat/1	5.80
158499	JOJOBA	Melon	Cotton/40	0.08
161131	BEANS, LIMAS, LG. DRY	DryBeans	Cotton/2	1.68
161132	BEANS, LIMAS, BABY DRY	DryBeans	Cotton/2	1.68
161199	LIMA BEANS, UNSPECIFIED	DryBeans	Cotton/2	1.68
161717	BEANS, RED KIDNEY	DryBeans	Cotton/2	1.68
161721	BEANS, PINK	DryBeans	Cotton/2	1.68
161741	BEANS, BLACKEYE (PEAS)	DryBeans	Cotton/2	1.68
161742	BEANS, GARBANZO	Garbanzo	Cotton/2	1.68
162399	BEANS, FAVA	DryBeans	Cotton/2	1.68
163999	PEAS, DRY EDIBLE	DryBeans	Cotton/20	0.17
169999	BEANS, UNSPEC. DRY EDIBLE	DryBeans	Cotton/2	1.68
171019	SEED WHEAT	Wheat	Wheat/1	5.80
171049	SEED RYE	Wheat	Wheat/1	5.80
171069	SEED RICE	Rice	Cotton/2	1.68
171129	SEED OATS	Wheat	Wheat/1	5.80
171139	SEED BARLEY	Wheat	Wheat/1	5.80
171519	SEED, COTTON FOR PLANTING	Cotton	Cotton/1	3.37
171582	SEED, SAFFLOWER, PLANTING	Safflower	Wheat/1	5.80

Table B. Crop Emission Factor Assumption and PM10 Harvest Emission Factor

CDFA Commodity Code	CDFA Crop Description	ARB Crop Profile	Crop EF Assumption	Harvest EF (lbs PM10/acre/year)
171619	SEED BEANS	DryBeans	Cotton/2	1.68
171639	SEED PEAS	DryBeans	Cotton/20	0.17
171949	SEED, MISC FIELD CROP	Corn	Cotton/20	0.17
171959	SEED, VEG & VINECROP	Vegetables	Cotton/20	0.17
172119	SEED, ALFALFA	Alfalfa	Zero/1	0.00
172289	CLOVER, UNSPECIFIED SEED	Alfalfa	Zero/1	0.00
173079	SEED, BERMUDA GRASS	Alfalfa	Zero/1	0.00
173669	SEED, SUDAN GRASS	Alfalfa	Zero/1	0.00
173999	SEED, GRASS, UNSPECIFIED	Alfalfa	Zero/1	0.00
178999	SEED, OTHER (NO FLOWERS)	Alfalfa	Cotton/20	0.17
181999	HAY, ALFALFA	Alfalfa	Zero/1	0.00
188499	HAY, GRAIN	Alfalfa	Cotton/2	1.68
188799	HAY, WILD	Alfalfa	Cotton/2	1.68
188899	HAY, SUDAN	Alfalfa	Zero/1	0.00
188999	HAY, OTHER UNSPECIFIED	Alfalfa	Cotton/2	1.68
195199	SILAGE	Wheat	Cotton/20	0.17
195299	HAY, GREEN CHOP	Alfalfa	Zero/1	0.00
195399	STRAW	Alfalfa	Wheat/1	5.80
198199	RICE, WILD	Rice	Cotton/2	1.68
198999	FIELD CROPS, UNSPEC.	Corn	Cotton/20	0.17
201119	ORANGES, NAVEL	Citrus	Cotton/40	0.08
201519	ORANGES, VALENCIAS	Citrus	Cotton/40	0.08
201999	ORANGES, UNSPECIFIED	Citrus	Cotton/40	0.08
202999	GRAPEFRUIT, ALL	Citrus	Cotton/40	0.08
203999	TANGERINES & MANDARINS	Citrus	Cotton/40	0.08
204999	LEMONS, ALL	Citrus	Cotton/40	0.08
205999	LIMES, ALL	Citrus	Cotton/40	0.08
206999	TANGELOS	Citrus	Cotton/40	0.08
207999	KUMQUATS	Citrus	Cotton/40	0.08
208059	CITRUS, MISC BY-PROD	Citrus	Cotton/40	0.08
209999	CITRUS, UNSPECIFIED	Citrus	Cotton/40	0.08
211999	APPLES, ALL	Citrus	Cotton/40	0.08
212199	PEACHES, FREESTONE	Citrus	Cotton/40	0.08
212399	PEACHES, CLINGSTONE	Citrus	Cotton/40	0.08
212999	PEACHES, UNSPECIFIED	Citrus	Cotton/40	0.08
213199	CHERRIES, SWEET	Citrus	Cotton/40	0.08
214199	PEARS, BARLETT	Citrus	Cotton/40	0.08
214899	PEARS, ASIAN	Citrus	Cotton/40	0.08
214999	PEARS, UNSPECIFIED	Citrus	Cotton/40	0.08
215199	PLUMS	Citrus	Cotton/40	0.08
215399	PLUMCOTS	Citrus	Cotton/40	0.08
215999	PRUNES, DRIED	Citrus	Cotton/40	0.08
216199	GRAPES, TABLE	Grapes-Table	Cotton/20	0.17
216299	GRAPES, WINE	Grapes-Wine	Cotton/20	0.17
216399	GRAPES, RAISIN	Grapes-Raisin	Cotton/20	0.17
216999	GRAPES, UNSPECIFIED	Grapes-Wine	Cotton/20	0.17
217999	APRICOTS, ALL	Citrus	Cotton/40	0.08
218199	NECTARINES	Citrus	Cotton/40	0.08
218299	PERSIMMONS	Citrus	Cotton/40	0.08
218399	POMEGRANATES	Citrus	Cotton/40	0.08
218499	QUINCE	Citrus	Cotton/40	0.08
218839	CHERIMOYAS	Citrus	Cotton/40	0.08
218889	ORCHARD BIOMASS	Almonds	Cotton/40	0.08
218899	FRUITS & NUTS, UNSPEC.	Citrus	Cotton/40	0.08
221999	AVOCADOS, ALL	Citrus	Cotton/40	0.08
224999	DATES	Citrus	Almonds/20	1.56
225999	FIGS, DRIED	Citrus	Almonds/20	1.56
226999	OLIVES	Citrus	Cotton/40	0.08
228019	GUAVAS	Citrus	Cotton/40	0.08
229999	KIWIFRUIT	Citrus	Cotton/40	0.08
230639	BERRIES, BLACKBERRIES	Grapes-Table	Cotton/40	0.08
230869	BERRIES, BOYSENBERRIES	Grapes-Table	Cotton/40	0.08

Table B. Crop Emission Factor Assumption and PM10 Harvest Emission Factor

CDFA Commodity Code	CDFA Crop Description	ARB Crop Profile	Crop EF Assumption	Harvest EF (lbs PM10/acre/year)
234799	BERRIES, LOGANBERRIES	Grapes-Table	Cotton/40	0.08
236199	BERRIES, RASPBERRIES	Grapes-Table	Cotton/40	0.08
237199	STRAWBERRIES, FRESH MKT	Melon	Cotton/40	0.08
237299	STRAWBERRIES, PROC	Melon	Cotton/40	0.08
237999	STRAWBERRIES, UNSPECIFIED	Melon	Cotton/40	0.08
238199	BERRIES BUEBERRIES	Grapes-Table	Cotton/40	0.08
239999	BUSHBERRIES UNSPECIFIED	Grapes-Table	Cotton/40	0.08
261999	ALMONDS, ALL	Almonds	Almonds/1	31.2
263999	WALNUTS, ENGLISH	Almonds	Almonds/1	31.2
264999	PECANS	Almonds	Almonds/10	3.12
265999	WALNUTS, BLACK	Almonds	Almonds/1	31.2
266999	CHESTNUTS	Almonds	Almonds/10	3.12
267999	MACADAMIA NUT	Almonds	Almonds/10	3.12
268079	PISTACHIOS	Almonds	Almonds/10	3.12
268099	ALMOND HULLS	Almonds	Almonds/1	31.2
301999	ARTICHOKES	Melon	Cotton/40	0.08
302199	ASPARAGUS, FRESH MKT	Melon	Cotton/2	1.68
302299	ASPARAGUS, PROC	Melon	Cotton/2	1.68
302999	ASPARAGUS, UNSPECIFIED	Melon	Cotton/2	1.68
303999	BEANS, GREEN LIMAS	DryBeans	Cotton/2	1.68
304199	BEANS, SNAP FR MKT	DryBeans	Cotton/20	0.17
304299	BEANS, SNAP PROC	DryBeans	Cotton/20	0.17
304399	BEANS FRESH UNSPECIFIED	DryBeans	Cotton/20	0.17
304999	BEANS, UNSPECIFIED SNAP	DryBeans	Cotton/20	0.17
305999	BEETS, GARDEN	Sugar Beets	Cotton/2	1.68
306999	RAPINI	Sugar Beets	Cotton/40	0.08
307189	BROCCOLI,FOOD SERV	Vegetables	Cotton/40	0.08
307199	BROCCOLI, FR MKT	Vegetables	Cotton/40	0.08
307299	BROCCOLI, PROC	Vegetables	Cotton/40	0.08
307919	BROCCOLI, UNSPECIFIED	Vegetables	Cotton/40	0.08
308999	BRUSSELS SPROUTS	Melon	Cotton/40	0.08
309999	CABBAGE, CH. & SPECIALTY	Lettuce	Cotton/40	0.08
310999	CABBAGE, HEAD	Lettuce	Cotton/40	0.08
313189	CARROTS, FOOD SERV	Sugar Beets	Cotton/20	0.17
313199	CARROTS, FR MKT	Sugar Beets	Cotton/20	0.17
313299	CARROTS, PROC	Sugar Beets	Cotton/20	0.17
313999	CARROTS, UNSPECIFIED	Sugar Beets	Cotton/20	0.17
314189	CAULIFLOWER, FOOD SERV	Vegetables	Cotton/40	0.08
314199	CAULIFLOWER, FR MKT	Vegetables	Cotton/40	0.08
314299	CAULIFLOWER, PROC	Vegetables	Cotton/40	0.08
314999	CAULIFLOWER, UNSPECIFIED	Vegetables	Cotton/40	0.08
316189	CELERY, FOOD SERV	Lettuce	Cotton/40	0.08
316199	CELERY, FR MKT	Lettuce	Cotton/40	0.08
316299	CELERY, PROC	Lettuce	Cotton/40	0.08
316999	CELERY, UNSPECIFIED	Lettuce	Cotton/40	0.08
318999	RADICCHIO	Lettuce	Cotton/40	0.08
320999	CHIVES	Lettuce	Cotton/40	0.08
322999	COLLARD GREENS	Lettuce	Cotton/40	0.08
323999	CORN, SWEET ALL	Corn	Cotton/40	0.08
325999	CUCUMBERS	Vegetables	Cotton/40	0.08
330999	EGGPLANT, ALL	Vegetables	Cotton/40	0.08
331999	ENDIVE, ALL	Lettuce	Cotton/40	0.08
332999	ESCAROLE, ALL	Lettuce	Cotton/40	0.08
333999	ANISE (FENNEL)	Lettuce	Cotton/2	1.68
335999	GARLIC, ALL	Garlic	Cotton/2	1.68
337999	KALE	Lettuce	Cotton/40	0.08
338999	KOHLRABI	Lettuce	Cotton/40	0.08
339196	LETTUCE, BULK SALAD PRODS.	Lettuce	Cotton/40	0.08
339999	LETTUCE, UNSPECIFIED	Lettuce	Cotton/40	0.08
340999	LETTUCE, HEAD	Lettuce	Cotton/40	0.08
341999	LETTUCE, ROMAINE	Lettuce	Cotton/40	0.08
342999	LETTUCE, LEAF	Lettuce	Cotton/40	0.08

Table B. Crop Emission Factor Assumption and PM10 Harvest Emission Factor

CDFA Commodity Code	CDFA Crop Description	ARB Crop Profile	Crop EF Assumption	Harvest EF (lbs PM10/acre/year)
343999	MELON, CANTALOUPE	Melon	Cotton/40	0.08
348999	MELON, HONEYDEW	Melon	Cotton/40	0.08
354299	MELON, UNSPECIFIED	Melon	Cotton/40	0.08
354999	MELON, WATER MELONS	Melon	Cotton/40	0.08
356999	MUSTARD	Lettuce	Cotton/40	0.08
357999	OKRA	Lettuce	Cotton/40	0.08
358999	ONIONS	Onions	Cotton/2	1.68
359999	PARSLEY	Lettuce	Cotton/40	0.08
361299	PEAS, GREEN, PROCESSING	DryBeans	Cotton/20	0.17
361999	PEAS, GREEN, UNSPECIFIED	DryBeans	Cotton/20	0.17
363999	PEPPERS, BELL	Tomatoes	Cotton/40	0.08
364999	PEPPERS, CHILI, HOT	Tomatoes	Cotton/40	0.08
366999	PUMPKINS	Melon	Cotton/20	0.17
367999	RADISHES	Sugar Beets	Cotton/40	0.08
368999	RHUBARB	Lettuce	Cotton/40	0.08
370999	RUTABAGAS	Sugar Beets	Cotton/2	1.68
372999	ONIONS, GREEN & SHALLOTS	Onions	Cotton/40	0.08
374189	SPINACH, FOOD SERV	Lettuce	Cotton/40	0.08
374199	SPINACH, FR MKT	Lettuce	Cotton/40	0.08
374299	SPINACH, PROC	Lettuce	Cotton/40	0.08
374999	SPINACH UNSPECIFIED	Lettuce	Cotton/40	0.08
375999	SQUASH	Melon	Cotton/20	0.17
376999	SWISSCHARD	Lettuce	Cotton/40	0.08
378199	TOMATOES, FRESH MARKET	Tomatoes	Cotton/40	0.08
378299	TOMATOES, PROCESSING	Tomatoes	Cotton/20	0.17
378999	TOMATOES, UNSPECIFIED	Tomatoes	Cotton/20	0.17
380999	TURNIPS, ALL	Sugar Beets	Cotton/2	1.68
381999	GREENS, TURNIP & MUSTARD	Lettuce	Cotton/40	0.08
387999	LEEKs	Onions	Cotton/40	0.08
391999	POTATOES, IRISH ALL	Sugar Beets	Cotton/2	1.68
392999	SWEET POTATOES	Sugar Beets	Cotton/2	1.68
393999	HORSERADISH	Onions	Cotton/40	0.08
394199	SALAD GREENS NEC	Lettuce	Cotton/40	0.08
394999	PEAS, EDIBLE POD (SNOW)	DryBeans	Cotton/20	0.17
395999	VEGETABLES, ORIENTAL, ALL	Vegetables	Cotton/40	0.08
396999	SPROUTS, ALFALFA & BEAN	Lettuce	Cotton/40	0.08
398199	CUCUMBERS, GREENHOUSE	No Land Prep.	Zero/1	0.00
398299	TOMATOES, GREENHOUSE	No Land Prep.	Zero/1	0.00
398399	TOMATOES, CHERRY	Tomatoes	Cotton/40	0.08
398499	TOMATILLO	Tomatoes	Cotton/40	0.08
398559	CILANTRO	Lettuce	Cotton/40	0.08
398599	SPICES AND HERBS	Lettuce	Cotton/40	0.08
398899	VEGETABLES, BABY	Vegetables	Cotton/40	0.08
398999	VEGETABLES, UNSPECIFIED	Vegetables	Cotton/20	0.17
832919	POTATOES SEED	Sugar Beets	Cotton/2	1.68

Temporal Data. Activity profiles are used to distribute annual emissions to the summer months (May - October) and winter months (November - April). The crop activity profiles shown in Table 2 are based on ARB crop calendars (non-SJV regions) or SJV AB calendars (SJV regions) and indicate the percentage of annual harvesting operations occurring each month. The temporal activity for each COABDIS region, shown in Table 3, reflects the monthly distribution of annual harvesting emissions from all associated crops. Monthly emissions are calculated by multiplying annual emissions by the monthly fraction. Harvesting operations are assumed to occur primarily during

the day, seven days a week. No adjustments are made for rainfall as the crop calendars are assumed to reflect seasonal activity patterns.

Growth Parameter. For all regions of the state except the SJV AB, growth reflects linear regressions of 2000-2009 NASS harvested crop acreage for regions showing a definite trend (-3% to +3% annually) and no growth when the regression analysis showed either no observable trend or an unsustainable trend. For the SJV AB, growth reflects linear regressions of 2000-2009 FMMP farmland acreage by COABDIS, applied to NASS harvested crop acreage for base year 2007. For all regions, growth is projected to 2020.

Changes in Method and Emissions Estimate. The significant changes for the April 2016 update include:

- Activity data was updated to reflect 2012 USDA NASS harvested crop acreage, as compiled by California Agricultural Commissioners.
- County specific temporal profiles were updated to reflect seasonal variations in emissions, based on the mix of crops and associated harvested acreage.

These changes produced an emissions increase of about 12% from the previous 2008 published inventory estimates, due to an increase in almond and walnut acreage.

The significant changes for the March 2017 revision include:

- Temporal profiles were revised for SJV AB regions, based on SJV Air District refinements to existing crop profiles and the development of 26 additional crop profiles.

These changes resulted in a reallocation of seasonal emissions for the SJV AB from 98% summer:2% winter to 85% summer:15% winter.

PREPARED BY

Janet Spencer
April 2016

REVISED BY

Janet Spencer
March 2017

Incorporated revised temporal profiles for the SJV Air Basin, based on SJV Air District refinements to crop profiles.

REFERENCES

1. California Air Resources Board. California Almanac of Emissions and Air Quality, 2009 Edition, Appendix D: Surface Area, Population and Average Daily Vehicle Miles Traveled. <http://www.arb.ca.gov/aqd/almanac/almanac09/appd09.htm>
2. California Air Resources Board. Detailed Documentation for Fugitive Dust and Ammonia Emission Inventory Changes for the SJVUAPCD Particulate Matter SIP. April 2003. http://www.valleyair.org/Air_Quality_Plans/docs/2003%20PM10%20Plan/PDF%202003%20PM10%20Plan%20adpt%20ref/R12-Inventory%20Doc%20Memos%20SJV%204_2003.pdf
3. California Air Resources Board, Speciation Profiles Used in ARB Modeling. PMSIZE Spreadsheet, Speciation Profile #417. <http://www.arb.ca.gov/ei/speciate/dnldoptvv10001.php#specprof>
4. California Department of Conservation, Farmland Mapping and Monitoring Program <http://www.conservation.ca.gov/dlrp/fmmp/Pages/Index.aspx>
5. Cowherd, C. Analysis of the Fine Fraction of Particulate Matter in Fugitive Dust, Final Report for Western Governors' Association, Western Regional Air Partnership (WRAP). October 12, 2005. Midwest Research Institute. MRI Project No. 110397. http://www.epa.gov/ttn/chief/ap42/ch13/related/mri_final_fine_fraction_dust_report.pdf
6. Faulkner, William B., Goodrich, Barry, Capareda, Sergio and Flocchini, Robert. White Paper for the San Joaquin Valley Unified Pollution Control District (SJVAPUCD), Recommended PM10 Emission Factors for Almond Harvesting. Texas A&M University. 2010. <http://www.almondboard.com/PR/A.2009.09-AIR7-Faulkner.Faulkner.Summary%20of%20PM%20Emission%20Studies%20from%20Almond%20Harvest.pdf>
7. Flocchini, R.G., James, T.A., et al. Sources and Sinks of PM10 in the San Joaquin Valley (Interim Report), a study for United State Department of Agriculture Special Research Grants Program. Contract Nos. 94-33825-0383 and 98-38825-6063. Air Quality Group, Crocker Nuclear Laboratory, University of California, Davis. August 10, 2001. <http://www.arb.ca.gov/research/apr/reports/l2022.pdf>
8. Gaffney, P. Updating ARB PM_{2.5} Size Speciation Profiles for Fugitive Dust Sources. California Air Resources Board. August 2006. <http://www.arb.ca.gov/ei/areasrc/fullpdf/2006pm2.5profiles.pdf>
9. Gaffney, P. Miscellaneous Process Methodologies, Agricultural Harvest Operations, Section 7.5. California Air Resources Board. January 2003. <http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-5.pdf>
10. Griffin, A. Forecasts of Farmed Acreage. California Air Resources Board. December 6, 2011.

11. Houck, J.E., Chow, J.C., Watson, J.G. et al. Determination of Particle Size Distribution and Chemical Composition of Particulate Matter from Selected Sources in California, Final Report. Desert Research Institute and OMNI Environmental. Prepared for the California Air Resources Board. Agreement No. A6-175-32. June 30, 1989. <http://www.arb.ca.gov/ei/speciate/r01t20/rf20doc/refnum20.htm>
12. San Joaquin Valley Air Pollution Control District. Areawide Emission Inventory Methodologies. http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/EmissionsMethods.htm
13. Jones, Derek, "Evaluation of Arrayed-Field Concentration Measurements and U. S. EPA-Regulatory Models for the Determination of Mixed-source Particulate Matter Emissions" (2008). *All Graduate Theses and Dissertations*. Paper 156. Utah State University. December 2008. <http://digitalcommons.usu.edu/etd/156>
14. Spencer, J. ARB Miscellaneous Method Section 7.5, Agricultural Harvesting Operations. December 2013. http://www.arb.ca.gov/areasrc/fullpdf/full7-5_2013.pdf
15. Spencer, J. 2012 Adoption of a Revised Harvesting Emission Factor for Almonds. California Air Resources Board, September 7, 2012. <http://www.arb.ca.gov/ei/areasrc/fullpdf/2012almondef.pdf>
16. United States Department of Agriculture, National Agricultural Statistics Service, California County Agricultural Commissioners' Data for Crop Years 2005 and 2007. http://www.nass.usda.gov/Statistics_by_State/California/Publications/AqComm/Detail/index.asp

Table 1
2012 Emissions from Agricultural Harvest Operations

Air Basin	County	Air District	Harvested Acres	Emissions, tons/year		
				PM10	PM2.5	Total PM
GBV	Alpine	GBU	150.00	0.13	0.02	0.28
GBV	Inyo	GBU	5,028.00	1.46	0.22	3.20
GBV	Mono	GBU	15,933.00	4.58	0.69	10.07
LC	Lake	LAK	15,605.00	52.33	7.85	115.19
LT	El Dorado	ED	325.89	0.19	0.03	0.43
LT	Placer	PLA	1,028.05	1.54	0.23	3.40
MC	Amador	AMA	6,271.00	5.63	0.85	12.40
MC	Calaveras	CAL	2,125.00	12.43	1.86	27.35
MC	El Dorado	ED	3,295.11	1.95	0.29	4.30
MC	Mariposa	MPA	104.00	0.01	0.00	0.02
MC	Nevada	NSI	312.00	0.03	0.00	0.06
MC	Placer	PLA	13,364.65	20.08	3.01	44.19
MC	Plumas	NSI	10,000.00	3.37	0.51	7.42
MC	Sierra	NSI	3,550.00	1.90	0.29	4.19
MC	Tuolumne	TUO	560.00	0.26	0.04	0.58
MD	Kern	KER	15,759.98	54.05	8.11	118.98
MD	Los Angeles	AV	5,110.78	1.27	0.19	2.80
MD	Riverside	MOJ	31,548.09	17.17	2.58	37.79
MD	Riverside	SC	46,394.25	25.25	3.79	55.57
MD	San Bernardino	MOJ	25,338.64	3.24	0.49	7.12
NC	Del Norte	NCU	2,600.00	2.19	0.33	4.82
NC	Humboldt	NCU	10,600.00	8.93	1.34	19.66
NC	Mendocino	MEN	18,925.00	1.52	0.23	3.34
NC	Sonoma	NS	50,931.32	8.42	1.26	18.53
NC	Trinity	NCU	664.00	0.47	0.07	1.04
NCC	Monterey	MBU	373,871.00	44.53	6.68	98.03
NCC	San Benito	MBU	47,657.00	38.97	5.84	85.77
NCC	Santa Cruz	MBU	17,226.00	0.87	0.13	1.92
NEP	Lassen	LAS	72,743.00	42.66	6.40	93.89
NEP	Modoc	MOD	86,465.00	61.12	9.17	134.54
NEP	Siskiyou	SIS	104,817.00	88.11	13.22	193.95
SC	Los Angeles	SC	5,763.22	1.43	0.22	3.16
SC	Orange	SC	1,035.00	0.05	0.01	0.10
SC	Riverside	SC	51,961.56	28.28	4.24	62.24
SC	San Bernardino	SC	1,617.36	0.21	0.03	0.45
SCC	San Luis Obispo	SLO	108,293.00	84.36	12.65	185.69
SCC	Santa Barbara	SB	117,363.00	12.79	1.92	28.14
SCC	Ventura	VEN	93,692.00	7.39	1.11	16.27
SD	San Diego	SD	49,072.00	6.43	0.97	14.16

Table 1
2012 Emissions from Agricultural Harvest Operations

Air Basin	County	Air District	Harvested Acres	Emissions, tons/year		
				PM10	PM2.5	Total PM
SF	Alameda	BA	10,035.00	4.74	0.71	10.43
SF	Contra Costa	BA	30,709.00	17.48	2.62	38.49
SF	Marin	BA	4,096.00	1.87	0.28	4.11
SF	Napa	BA	44,036.00	4.18	0.63	9.19
SF	San Francisco	BA	0	0	0	0
SF	San Mateo	BA	3,141.00	1.75	0.26	3.86
SF	Santa Clara	BA	19,407.00	6.79	1.02	14.94
SF	Solano	BA	50,426.00	122.46	18.37	269.56
SF	Sonoma	BA	23,967.68	3.96	0.59	8.72
SJV	Fresno	SJU	1,073,350.00	3,025.90	453.88	6,660.57
SJV	Kern	SJU	772,239.04	2,648.47	397.27	5,829.78
SJV	Kings	SJU	557,583.00	887.85	133.18	1,954.32
SJV	Madera	SJU	310,420.00	1,542.44	231.37	3,395.20
SJV	Merced	SJU	562,198.00	1,834.17	275.12	4,037.34
SJV	San Joaquin	SJU	690,367.00	1,985.94	297.89	4,371.44
SJV	Stanislaus	SJU	538,956.00	3,107.40	466.11	6,839.98
SJV	Tulare	SJU	893,908.00	1,271.93	190.79	2,799.75
SS	Imperial	IMP	565,617.00	376.07	56.41	827.80
SS	Riverside	SC	55,673.10	30.30	4.54	66.69
SV	Butte	BUT	213,910.00	1,326.61	198.99	2,920.11
SV	Colusa	COL	294,470.00	1,051.46	157.72	2,314.46
SV	Glenn	GLE	242,036.00	1,021.43	153.21	2,248.36
SV	Placer	PLA	6,168.30	9.27	1.39	20.40
SV	Sacramento	SAC	127,756.00	84.91	12.74	186.90
SV	Shasta	SHA	30,060.00	36.32	5.45	79.99
SV	Solano	YS	82,274.00	199.80	29.97	439.81
SV	Sutter	FR	230,115.00	660.88	99.13	1,454.72
SV	Tehama	TEH	63,510.00	502.95	75.44	1,107.10
SV	Yolo	YS	412,022.00	713.47	107.02	1,570.48
SV	Yuba	FR	63,866.00	228.22	34.23	502.35
Statewide Totals			9,389,416	23,355	3,503	51,408

Table 2
 Monthly Agricultural Harvest Activity by Crop for 2012
 (Annual sum of monthly values may not equal 100 due to rounding)

Crop Profile	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Alfalfa	0.00	0.00	14.29	14.29	14.29	14.29	14.29	14.29	14.29	0.00	0.00	0.00
Almonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00
Citrus	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00
Cotton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00
DryBeans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00
Garbanzo	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00
Garlic	0.00	0.00	0.00	0.00	0.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00
Grapes-Raisin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
Grapes-Table	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
Grapes-Wine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
Lettuce	0.00	0.00	25.00	25.00	0.00	0.00	0.00	0.00	0.00	25.00	25.00	0.00
Melon	0.00	0.00	0.00	0.00	0.00	25.00	25.00	25.00	25.00	0.00	0.00	0.00
Onions	0.00	0.00	0.00	0.00	0.00	20.00	20.00	20.00	20.00	20.00	0.00	0.00
Rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	33.33	33.33	0.00
Safflower	0.00	0.00	0.00	0.00	0.00	0.00	33.33	33.33	33.33	0.00	0.00	0.00
Sugar Beets	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33
Tomatoes	0.00	0.00	0.00	0.00	0.00	0.00	33.33	33.33	33.33	0.00	0.00	0.00
Vegetables	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33	8.33
Wheat	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00

Miscellaneous Process Methodology 7.5 — Agricultural Harvest Operations

Table 3
 Monthly PM Emission Profiles for 2012 Agricultural Harvest Operations
 (Monthly % of annual emissions, normalized to 1.0; sum of monthly values may not equal 100 due to rounding)

Air Basin	County	Air District	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
GBV	Alpine	GBU	0.00	0.00	14.29	14.29	14.29	14.29	14.29	14.29	14.29	0.00	0.00	0.00
GBV	Inyo	GBU	0.01	0.01	14.28	14.28	14.28	14.28	14.28	14.28	14.28	0.01	0.01	0.01
GBV	Mono	GBU	0.34	0.34	13.44	13.44	13.44	14.29	14.29	14.29	14.29	1.18	0.34	0.34
LC	Lake	LAK	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	49.27	49.27	1.33	0.01
LT	El Dorado	ED	0.20	0.20	1.46	1.46	1.46	1.46	1.46	1.46	41.80	40.54	8.29	0.20
LT	Placer	PLA	0.00	0.00	0.29	0.29	0.29	6.45	6.45	0.30	35.85	35.56	14.52	0.00
MC	Amador	AMA	0.00	0.00	2.60	2.60	2.60	2.60	2.60	2.60	40.51	37.92	5.98	0.00
MC	Calaveras	CAL	0.00	0.00	0.29	0.29	0.29	0.29	0.29	0.29	48.95	48.65	0.62	0.00
MC	El Dorado	ED	0.20	0.20	1.46	1.46	1.46	1.46	1.46	1.46	41.80	40.54	8.29	0.20
MC	Mariposa	MPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
MC	Nevada	NSI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
MC	Placer	PLA	0.00	0.00	0.29	0.29	0.29	6.45	6.45	0.30	35.85	35.56	14.52	0.00
MC	Plumas	NSI	0.00	0.00	14.29	14.29	14.29	14.29	14.29	14.29	14.29	0.00	0.00	0.00
MC	Sierra	NSI	0.00	0.00	14.29	14.29	14.29	14.29	14.29	14.29	14.29	0.00	0.00	0.00
MC	Tuolumne	TUO	0.37	0.37	14.02	14.02	14.02	14.02	14.02	14.02	14.02	0.37	0.37	0.37
MD	Kern	KER	0.05	0.05	0.18	0.18	0.18	3.25	3.42	0.41	44.29	45.78	2.16	0.05
MD	Los Angeles	AV	0.00	0.00	14.05	14.05	14.05	14.05	14.08	14.08	14.19	0.11	1.34	0.00
MD	Riverside	MOJ	1.17	1.17	2.07	2.07	1.99	27.81	27.89	2.13	2.27	14.79	15.49	1.17
MD	Riverside	SC	1.17	1.17	2.07	2.07	1.99	27.81	27.89	2.13	2.27	14.79	15.49	1.17
MD	San Bernardino	MOJ	0.39	0.39	9.56	9.56	8.26	12.50	12.51	8.39	20.95	14.25	2.86	0.39
NC	Del Norte	NCU	0.00	0.00	14.29	14.29	14.29	14.29	14.29	14.29	14.29	0.00	0.00	0.00
NC	Humboldt	NCU	0.00	0.00	14.29	14.29	14.29	14.29	14.29	14.29	14.29	0.00	0.00	0.00
NC	Mendocino	MEN	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	93.78	0.57
NC	Sonoma	NS	0.12	0.12	5.48	5.48	5.48	16.07	16.07	5.48	5.56	0.20	39.80	0.12
NC	Trinity	NCU	0.00	0.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	0.00	2.03	0.00
NCC	Monterey	MBU	1.21	1.21	5.83	5.83	1.51	24.25	24.33	3.95	4.16	9.49	17.02	1.21
NCC	San Benito	MBU	0.14	0.14	4.79	4.79	4.43	4.83	5.05	5.05	36.76	32.60	1.28	0.14
NCC	Santa Cruz	MBU	3.22	3.22	6.83	6.83	3.22	9.21	9.21	9.21	9.21	6.83	29.81	3.22
NEP	Lassen	LAS	0.00	0.00	11.10	11.10	11.10	20.55	20.55	11.10	12.23	1.13	1.13	0.00
NEP	Modoc	MOD	0.55	0.55	6.47	6.47	6.47	32.03	32.03	6.75	6.75	0.84	0.56	0.55
NEP	Siskiyou	SIS	0.28	0.28	1.92	1.92	1.92	43.24	43.24	2.24	3.03	1.39	0.28	0.28
SC	Los Angeles	SC	0.00	0.00	14.05	14.05	14.05	14.05	14.08	14.08	14.19	0.11	1.34	0.00
SC	Orange	SC	0.89	0.89	1.03	1.03	0.89	22.36	22.96	22.96	22.96	2.11	1.03	0.89
SC	Riverside	SC	1.17	1.17	2.07	2.07	1.99	27.81	27.89	2.13	2.27	14.79	15.49	1.17
SC	San Bernardino	SC	0.39	0.39	9.56	9.56	8.26	12.50	12.51	8.39	20.95	14.25	2.86	0.39
SCC	San Luis Obispo	SLO	0.16	0.16	1.74	1.74	1.65	21.98	22.00	1.71	23.13	21.67	3.91	0.16
SCC	Santa Barbara	SB	1.95	1.95	7.37	7.37	5.81	7.17	7.21	6.54	6.82	16.32	29.55	1.95
SCC	Ventura	VEN	2.65	2.65	5.91	5.91	2.65	4.72	5.98	5.98	6.63	26.64	27.63	2.65
SD	San Diego	SD	2.63	2.63	11.66	11.66	11.52	11.77	12.11	12.11	13.22	4.01	4.03	2.63

Table 3
Monthly PM Emission Profiles for 2012 Agricultural Harvest Operations
(Monthly % of annual emissions, normalized to 1.0; sum of monthly values may not equal 100 due to rounding)

Air Basin	County	Air District	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SF	Alameda	BA	0.04	0.04	13.35	13.35	13.35	13.35	13.35	13.35	13.92	0.61	5.27	0.04
SF	Contra Costa	BA	0.07	0.07	1.51	1.51	1.51	6.13	6.47	1.86	40.73	39.04	1.04	0.07
SF	Marin	BA	0.12	0.12	13.07	13.07	13.07	16.60	16.60	13.07	13.07	0.12	0.96	0.12
SF	Napa	BA	0.02	0.02	1.82	1.82	1.82	1.82	1.82	1.82	1.82	0.02	87.19	0.02
SF	San Francisco	BA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SF	San Mateo	BA	0.17	0.17	3.29	3.29	3.29	33.97	33.97	4.09	4.09	6.46	7.01	0.17
SF	Santa Clara	BA	0.19	0.19	7.20	7.20	6.59	7.71	8.71	8.71	28.15	21.80	3.38	0.19
SF	Solano	BA	0.01	0.01	0.46	0.46	0.46	12.22	13.18	1.42	36.33	35.13	0.32	0.01
SF	Sonoma	BA	0.12	0.12	5.48	5.48	5.48	16.07	16.07	5.48	5.56	0.20	39.80	0.12
SJV	Fresno	SJU	0.01	0.08	3.20	3.27	0.22	0.30	0.38	16.72	37.17	27.21	10.29	1.13
SJV	Kern	SJU	0.01	0.03	3.11	3.25	0.25	0.27	0.45	17.24	37.99	26.87	9.83	0.69
SJV	Kings	SJU	0.01	0.01	9.78	9.81	0.34	0.35	0.35	10.95	26.27	25.66	12.19	4.27
SJV	Madera	SJU	0.00	0.00	0.70	0.72	0.06	0.15	0.20	18.83	41.46	28.10	9.74	0.03
SJV	Merced	SJU	0.00	0.00	1.57	1.77	0.46	0.48	0.48	17.41	38.64	27.86	10.37	0.95
SJV	San Joaquin	SJU	0.00	0.01	2.39	2.43	0.46	0.52	0.83	18.01	39.37	26.60	9.34	0.04
SJV	Stanislaus	SJU	0.00	0.00	0.35	0.45	0.23	0.23	0.23	18.87	41.61	28.25	9.77	0.01
SJV	Tulare	SJU	0.06	0.06	6.30	6.30	0.33	0.36	0.38	15.85	35.34	25.16	9.23	0.62
SS	Imperial	IMP	0.61	0.61	2.71	2.71	2.56	39.78	39.78	2.96	3.19	2.55	1.93	0.61
SS	Riverside	SC	1.17	1.17	2.07	2.07	1.99	27.81	27.89	2.13	2.27	14.79	15.49	1.17
SV	Butte	BUT	0.00	0.00	0.00	0.00	0.00	0.99	1.01	0.03	47.91	47.92	2.12	0.00
SV	Colusa	COL	0.01	0.01	0.03	0.03	0.03	2.27	2.46	0.22	45.19	45.21	4.53	0.01
SV	Glenn	GLE	0.01	0.01	0.03	0.03	0.03	1.74	1.74	0.03	46.71	46.95	2.69	0.01
SV	Placer	PLA	0.00	0.00	0.29	0.29	0.29	6.45	6.45	0.30	35.85	35.56	14.52	0.00
SV	Sacramento	SAC	0.05	0.05	0.46	0.46	0.46	17.61	19.90	2.74	27.85	25.16	5.22	0.05
SV	Shasta	SHA	0.00	0.00	6.59	6.59	6.59	6.59	6.59	6.59	31.29	24.70	4.44	0.00
SV	Solano	YS	0.01	0.01	0.46	0.46	0.46	12.22	13.18	1.42	36.33	35.13	0.32	0.01
SV	Sutter	FR	0.02	0.02	0.08	0.08	0.08	2.72	3.17	0.52	44.29	43.84	5.19	0.02
SV	Tehama	TEH	0.01	0.01	0.16	0.16	0.16	0.99	0.99	0.16	48.74	48.59	0.01	0.01
SV	Yolo	YS	0.01	0.01	0.20	0.20	0.20	7.48	8.95	1.68	40.58	38.91	1.75	0.01
SV	Yuba	FR	0.02	0.02	0.12	0.12	0.12	0.12	0.12	0.12	47.34	47.23	4.64	0.02